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Patentanmeldung Nr. Patent application No. Demande de brevet n°

99307556.3

## PRIORITY DOCUMENT

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**Blatt 2 der Bescheinigung  
Sheet 2 of the certificate  
Page 2 de l'attestation**

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**Dispensing devices**

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## DISPENSING DEVICES

This invention relates to devices for the dispensing of liquids into a carrier fluid.

Our patent application PCT/GB99/00998 describes  
5 apparatus for dispensing a volatile liquid into a surrounding atmosphere in which a driving airflow is used to draw the liquid from a conduit by producing a pressure drop in the region of an outlet from the conduit in the manner of a jet pump or venturi. The liquid conduit may  
10 be formed as a capillary tube and the airflow may be directed past the conduit outlet region through an air delivery nozzle having a similar size cross-section.

By the use of such devices with small cross-section nozzles, it is possible to achieve rapid  
15 dispersal of the liquid into the atmosphere using low mass air flows and to do this by means of a compact device with only a small power requirement. The present invention is concerned with further improvements of  
devices of this nature.

According to one aspect of the invention, there  
is provided a liquid dispensing device comprising an air pump, a vessel for the liquid to be dispensed, a syphon tube extending from a lower region of the vessel to an exit nozzle, an air outlet conduit for said pump provided  
25 with an outlet nozzle for directing a stream of pumped air past the liquid exit nozzle, the air outlet nozzle having an effective cross-sectional area not more than

twice that of the liquid exit nozzle.

The liquid conduit is preferably a capillary tube with a cross-sectional area about 10mm<sup>2</sup> or less. The liquid exit nozzle is no larger and can have a 5 substantially smaller cross-section eg. equivalent to a diameter of approximately 1-2mm.

The air outlet nozzle preferably has a cross-sectional area not substantially more than that of the liquid exit nozzle, or even up to about 40% less than the 10 liquid exit nozzle. It is also possible to form the air outlet nozzle as an orifice of a size similar to or greater than the liquid exit nozzle but with a smaller effective cross-sectional area by virtue of a baffle or other obstacle to the issuing flow immediately downstream 15 of the orifice. For example the liquid exit nozzle structure may project into and partly block the flow path from the orifice in the air flow path. This both reduces the effective cross-sectional area to increase the air flow velocity and generates unsteady flow conditions 20 which will enhance the dispersal of the liquid drawn into the flow.

Thus, according to another aspect, the invention provides a liquid dispensing device comprising a vessel for the liquid to be dispensed, an outlet passage 25 extending from a lower region of the vessel to a liquid exit nozzle, a conduit provided with an outlet nozzle for directing a stream of air past the liquid exit nozzle, the liquid exit nozzle extending into a projection of the

air outlet nozzle axially thereof to partially overlie said projection, the portion of the nozzle projection not so overlain having a cross-sectional area not substantially greater than the cross-section of the 5 liquid exit nozzle.

In the case in which the air outlet nozzle has an orifice substantially equal to or smaller than the liquid exit nozzle, a baffle or the like obstacle may be located downstream of the liquid exit nozzle to promote unsteady 10 flow conditions for accelerating the dispersal of the liquid in the airflow.

It is desirable to ensure that the outlet opening of the liquid exit nozzle of a liquid dispensing device according to the invention, at its closest to the air 15 outlet nozzle opening, is spaced not more than four times the mean cross-sectional dimension of the air outlet nozzle from that nozzle, in order to limit the degree of diffusion of the airstream before it flows across the liquid exit nozzle outlet, and preferably the spacing is 20 not substantially more than twice that dimension.

The invention is also concerned with arrangements of liquid dispensing devices in a manner suitable for large scale production.

Thus, in one arrangement according to a further 25 aspect of the invention, a liquid dispensing device is provided comprising a vessel for a liquid to be dispensed, a conduit extending upwardly from a lower region of the vessel to a liquid exit nozzle, and an air

pump connected to an outlet conduit having an air outlet nozzle opening adjacent said liquid exit nozzle to draw liquid therefrom by a flow of air through said outlet nozzle, said air and liquid nozzles being formed by a 5 pair of elements having opposed faces at which the elements are sealed together, said nozzles comprising depressions in at least one of said faces.

In an alternative arrangement, the liquid dispensing device comprises a vessel for a liquid to be dispensed, a conduit extending upwardly from a lower 10 region of the vessel to a liquid exit nozzle, and an air pump connected to an outlet conduit having an air outlet nozzle opening adjacent said liquid exit nozzle, at least the liquid exit nozzle being defined by a separately 15 formed insert. The air outlet nozzle may comprise a further insert and, to control their relative location, the inserts may be arranged to lie in contact with each other.

In accordance with yet another aspect of the 20 invention, a liquid dispensing device is provided comprising a pump for generating a carrier fluid flow, a replaceable vessel removably connected to a mounting communicating with a fluid flow exit from said generating means, said vessel providing a container for the liquid 25 to be dispensed, an outlet passage for said liquid extending between the mounting and a lower region of the vessel, said mounting of the device containing coacting nozzles for the flow from said generating means and the

liquid from said outlet passage to entrain the liquid in suspension in said fluid flow.

Examples of the invention will be described with reference to the accompanying drawings in which :

5 Fig. 1 is a cross-section in a central vertical plane of one form of device according to the invention,

Figs 2 and 3 are, respectively, an oblique exploded view and a front view of the device of Fig. 1 with the portions of the main body mouldings to one side 10 of the central vertical plane of symmetry omitted,

Fig. 4 is a detail sectional view in the plane of Fig. 1 of the air and liquid outlet in the device of Figs 1-3,

15 Fig. 5 is a detail sectional view illustrating an alternative arrangement of the liquid and air conduit outlets in the liquid container of another form of device according to the invention,

Fig. 6 is a view to a larger scale of the circled region in Fig. 5,

20 Fig. 7 is an exploded oblique illustration of the nozzle assembly of the device of Figs. 5 and 6,

Fig. 8 is a sectional view similar to Fig. 5 showing a further modified form of device according to the invention with half of the nozzle unit removed,

25 Figs 9 and 10 are front and oblique views of a unitary moulding that provides the air and liquid outlet nozzles in the device of Fig. 8,

Fig. 11 is a sectional view similar to Fig. 5

illustrating a yet further modified form of device according to the invention, and

Figs. 12 and 13 are, respectively, a larger scale view of the circled region in Fig. 11 and an exploded 5 view from below of the air and liquid outlet nozzles in the device of Figs. 11 and 12.

Referring to Figs. 1 to 4, the dispensing device is in the form of a plug-in unit intended to be mounted on an electrical supply socket by a 3-pin connection plug 10 12 at the rear of the device. The device has a casing comprising a rear body moulding 14 from which the plug pins project. A pumping unit 16 comprising an electric motor and an air pump is mounted on the rear moulding and is enclosed by a front cover moulding 18 permanently 15 secured to the rear moulding 14. At the bottom of the air pump is a centrically located spigot 20 on which a socket 22 of a nozzle unit 24 fits closely. The nozzle unit 24 projects into a container 26 which is detachably held in the unit casing by securing means (not shown) 20 between it and the rear moulding 14.

The nozzle unit 24 in this and the later examples may form an integral part of the air pump spigot 20 or of the container 26 and comprise a mating part that seals releasably with the container or the pump spigot 25 respectively. However, it may alternatively be a separate adaptor that, as shown in this example, fits as a sealing plug into the neck of the container 26 and, through the socket 22 in its top face, that similarly

seals with the spigot.

Also mounted on the rear moulding is a printed circuit board 32 providing electrical connection between the plug connection 12 and the pump motor and comprising 5 a variable time circuit which is controlled by a timer switch 34 slidably mounted on the front cover 18.

The nozzle unit 24 comprises a nozzle block 42 integral with the main body of the unit or formed as a plug-in member inserted into a side face of the unit, as 10 illustrated in Fig. 2 in particular. The nozzle block 42 has a through bore 44 communicating with the air pump outlet through a vertical passage 46 in the nozzle unit. An air nozzle 48 is located in the entry end of the bore 15 44 and abuts a liquid nozzle 50 which projects into the bore from below. Secured to the lower end of the liquid nozzle 50 is a capillary tube 52 which extends downwards to the bottom of the container 26.

The capillary tube diameter may be about 3mm. The bore of the liquid nozzle 50 is considerably smaller, 20 eg. not substantially more than 1mm diameter and possibly as small as 0.5mm or less. The bore of the air nozzle 48 may be of a similar size, or possibly smaller than the liquid nozzle bore, eg. with about half the cross-sectional area of the liquid nozzle bore. In addition, 25 the illustrated example shows effective size of the air nozzle exit further reduced because it is overlapped by the tip of the liquid nozzle.

In operation, the air pump produces an air jet

from the air nozzle 48. The jet velocity is relatively high although the small size of the air nozzle means the volumetric flow is relatively small. A reduced pressure is thereby produced over the exit from the liquid nozzle 50 and liquid is drawn from the nozzle as fine droplets which, because of the high air velocity, are rapidly dispersed in the air flow.

To employ the high velocity, low volume airflow from the air outlet nozzle efficiently the liquid exit nozzle should be located close to the air nozzle because the airstream will diffuse rapidly as it flows away from the air nozzle. If this effect is not controlled, a much greater mass flow of air would be required to take up the liquid. In the example of Fig. 4, the air nozzle outlet 10 is located some two diameters of the nozzle diameter from the liquid nozzle exit opening and the distance is 15 preferably no more than twice that.

The overlap of the liquid nozzle 50 with the air nozzle 48 has a further effect in forming an impingement surface disturbing the flow exiting from the air nozzle. This effect promotes the mixing of liquid into the air flow and helps to inhibit the formation of large liquid droplets which would hinder rapid dispersal in the airflow.

25 The resulting flow of air with liquid vapour and droplets is dispersed into the surrounding atmosphere through exit openings 54 in the front wall of the container. The exit openings 54 are at an angle to the

flow path from the nozzle unit bore 44 so the container front wall forms a further barrier for any larger liquid droplets in the flow. If such droplets strike the front wall they return into the main body of liquid in the container.

In the example of Figs. 5 to 7 the dispensing device may be a plug-in unit with a casing and a pumping unit arranged in the same manner as in the preceding example. The drawings show a modified air-liquid mixing arrangement in which a nozzle unit 62 between the air pump outlet spigot 20 and the liquid container 26 has an integral air nozzle. As in the first example, the spigot 20 is received in a socket 64 in the unit 62, and a conduit 66 communicating with the air pump outlet leads downwards from the socket. At its lower end the conduit 66 joins a deep but narrow slit-like passage 68 in the unit 62 providing an air outlet nozzle.

At the bottom of the nozzle unit 62, into a tubular extension 70 opening into the narrow passage 68 is inserted the capillary liquid tube 52. Above the tube 52 and projecting into the passage 68 is a liquid outlet nozzle 72 with a diameter over most of its height greater than the width of the passage 68.

The liquid outlet nozzle has a conical cap 74 with a central outlet opening 76 of a similar diameter to the outlet nozzle of Fig. 4, eg. 0.5mm to 1mm. It will be noted that the air conduit 66, which may have a circular bore, is considerably larger and, although it

10

opens into the smaller cross-section nozzle passage 68, the divergent rectangular cross-section of that passage is still considerably larger than the liquid nozzle outlet opening 76. However, the projection of the liquid outlet nozzle 72 into the air passage 68 reduces the free cross-section for the air flow substantially. Since the diameter of the base of the conical tip 74 is greater than the width of the passage 68, air can only flow past the liquid outlet nozzle close to the upper end of the conical tip. A nozzle throat is thus formed with an air flow cross-section which is preferably not substantially greater than the liquid outlet opening 76, and which in the illustrated example is smaller than that outlet opening.

Immediately downstream of the liquid nozzle the cross-section of the passage 68 increases sharply, so that there is a similarly sharp increase of static pressure which intensifies the mixing of the liquid drawn from the liquid outlet nozzle into the air flow. In the illustrated example, as is shown in Fig. 7, there is a step 78 in the passage wall at or adjacent the liquid nozzle outlet which promotes disturbance of the air flow and further increases the rate of mixing with the liquid drawn from the liquid nozzle.

The formation of flow passages of 1mm diameter or less with the accuracy required to control the pressure changes at the point of mixing is difficult to achieve economically in large scale production. To some extent

the use of nozzle inserts, as in the first-described example, and the control of their relative location by abutting the inserts against each other is able to reduce the extent to which precision manufacturing techniques  
5 are required. However, Figs. 8-10 illustrate another way in which the cost of manufacture can be substantially reduced.

In this example, again, only the container 26 and a nozzle unit 82 are shown and the remainder of the  
10 device may take the same form as in the first example. The air and liquid nozzles are integral parts of the nozzle unit 82 between the air pump spigot 20 and the liquid container 26. The unit 82 itself is a unitary plastics moulding having two opposed parts 84,86 joined  
15 by an integral hinge element 88 about which the two parts can be folded together to bring their opposed planar faces 84a,86a together, these mating faces being sealed together at their areas of contact. The socket 88 receiving the air pump spigot is formed as two  
20 semicircular recesses 88a,88b in the two parts 84,86 and conduits 90,92 respectively for the air and liquid flows to the nozzles are also divided to be formed by semi-circular grooves in the faces 84a,86a. In the abutting faces 84a,86a dowelling projections 94 are formed in the  
25 one part 84 for engagement with depressions 96 in the other part 86 to locate the matching recesses in the two parts together accurately.

The two parts of the moulding also share between

them corresponding recesses forming a divergent exit passage 98 for the mixed flow of air and liquid droplets. However, the air and liquid nozzles between the conduits 90, 92 and the exit passage 98 are formed as recesses 5 102, 104 respectively in only one of the parts because of their small cross-sectional size. Thus from one of the recesses forming the air supply conduit 90 the air nozzle 102 extends to intersect the liquid exit nozzle 104 which has a similar or somewhat larger cross-section and which 10 extends from one of the recesses forming the liquid supply conduit 92. At the downstream side of the liquid outlet nozzle 104 is a baffle 106 which reduces the outlet cross-section abruptly at the beginning of the divergent exit passage 98 to promote mixing in a similar 15 manner to the preceding examples.

The manufacture of a unitary moulding of the kind shown in Figs. 8-10 can be further simplified by forming further features, such as the conduits 90, 92 and the exit passage 98, in a face of one of the parts, the other part 20 then having a mainly or wholly planar mating face.

Figs. 11-13 show a further modified form of nozzle unit 110 devised with a view to simplifying manufacture of the dispensing device. Only part of the device is illustrated and the remainder of the device may 25 be as shown in Figs. 1-4. The nozzle unit 110 has a socket 112 receiving the air pump spigot 20 and it fits sealingly on the neck of the container 26 as in the earlier examples, but in this case the unit 110 carries a

plug insert 114 into which respective air and liquid nozzles 116,118 are in their turn fitted. The nozzle unit has upper and lower entry conduits 120,122 for the air and liquid flows respectively, the liquid capillary tube 52 being inserted into the lower conduit 122. Both conduits lead to a cross-passage 126 in which the plug insert 114 is a sealing fit.

The plug insert 114 has a through-bore 128 coaxial with the cross-passage 126 in the nozzle unit 110. A flat 130 on the insert 114 locates against a corresponding flat in the passage 126 to ensure that the plug insert is held in the nozzle unit with the liquid nozzle 118 aligned with the liquid entry conduit 122. Both nozzles 116,118 are rotationally symmetrical and can 15 be produced with a high accuracy using simple dies. The plug insert 114 is similarly able to be produced economically with high dimensional accuracy, but it is only necessary to control the dimensions of the main body of the adaptor to ensure it makes fluid-tight seals with 20 the parts to which it is attached.

Each nozzle has a locating flange 116a,118a that sets the depth of insertion into the plug insert 114. When fully entered, as shown in the Fig. 12 conical end face 116b of the air nozzle abuts the end face 118b of 25 the liquid nozzle. The liquid nozzle outlet has a diameter of 0.5mm and the air nozzle outlet diameter is smaller at 0.3mm, but in addition the air nozzle outlet is partly blocked by the overlapping tip of the liquid

nozzle, analogously to the first-described example. The effective exit flow area is thus reduced and, moreover, the facing side wall of the liquid nozzle forms a baffle that promotes unsteadiness in the exiting air flow.

CLAIMS

1. A liquid dispensing device comprising an air pump, a vessel for the liquid to be dispensed, a conduit extending from a lower region of the vessel to an exit nozzle, an outlet conduit for an air flow from said pump leading to an outlet nozzle for directing the air flow past the liquid exit nozzle to draw liquid in vapour and/or droplet form into said flow, the air outlet nozzle having a cross-section less than that of the liquid exit nozzle.
2. A device according to claim 1 wherein a baffle is located at or closely downstream of the air outlet nozzle and extends transversely over part of the cross-sectional extent of the nozzle or a continuation of the air flow path therefrom.
3. A device according to claim 2 wherein said baffle is formed by the liquid exit nozzle.
4. A device according to claim 2 wherein said baffle is located downstream of the liquid exit nozzle.
5. A device according to any one of the preceding claims wherein at least one of said nozzles is formed by a plug insert.

6. A liquid dispensing device comprising a vessel for the liquid to be dispensed, an outlet passage extending from a lower region of the vessel to a liquid exit nozzle, a conduit for a forced air flow  
5 communicating with an outlet nozzle for directing a stream of air past the liquid exit nozzle, the liquid exit nozzle extending in front of said outlet nozzle to overlie a part of an axial projection of said outlet nozzle air flow path, the remainder of the air flow path  
10 at the outlet from said nozzle being not substantially greater than the cross-section of the liquid flow path from the liquid exit nozzle.

7. A device according to claim 6 wherein the liquid exit nozzle is in abutment with the air outlet nozzle to form a baffle immediately adjacent the exit from said outlet nozzle, said projection of said nozzle air flow path clear of the baffle having a cross-section smaller than the liquid exit nozzle cross-section.  
15

8. A device according to claim 6 or claim 7 wherein  
20 the liquid exit nozzle is located between the air outlet nozzle and a downstream flow passage having a divergent cross-section.

9. A device according to any one of claims 6 to 8 wherein the air outlet nozzle is formed in an oblong  
25 cross-section air flow passage into which the liquid exit

nozzle projects with a liquid flow path extending substantially in the direction of the major dimension of said oblong cross-section, said liquid nozzle blocking air flow over a part of said major dimension of said  
5 oblong cross-section.

10. A liquid dispensing device comprising a vessel for a liquid to be dispensed, a conduit extending upwardly from a lower region of the vessel to a liquid exit nozzle, and an air outlet nozzle for a forced air flow opening adjacent said liquid exit nozzle to draw liquid into said air flow, a nozzle unit providing said air and liquid nozzles comprising a pair of elements having opposed faces at which the elements are sealed together, said nozzles being provided by depressions in  
15 at least one of said faces.

11. A device according to claim 10 wherein further depressions in at least one of said faces provide sockets for receiving air and liquid supply means, and means for connecting said supply means to said nozzles.

20 12. A device according to claim 10 or claim 11 wherein said sealed together elements comprise a baffle adjacent the nozzle exits for disturbing the mixed flow of air and liquid from said nozzles.

13. A device according to any one of claims 10 to 12

wherein at least one of said faces has an additional depression providing a divergent passage extending downstream from said air and liquid nozzles for the mixed flow from said nozzles.

5 14. A device according to any one of claims 10 to 13 wherein at least one of said nozzles is formed between a depression in one said element and a planar face of the other said element.

10 15. A liquid dispensing device comprising a pump for generating a carrier fluid flow, a replaceable vessel removably mounted in the device forming a container for the liquid to be dispensed, a nozzle unit detachably secured relative to said pump, and from which a liquid conduit depends into a lower region of the vessel, the 15 nozzle unit holding coacting nozzles for the carrier fluid and liquid from said conduit.

16. A device according to claim 15 wherein the nozzle unit is detachable from the vessel.

20 17. A device according to claim 15 or claim 16 wherein the nozzles are formed by plug inserts in the nozzle unit.

18. A device according to claim 17 wherein the nozzles are secured in a holder to be mutually aligned before insertion of the holder in the nozzle unit.

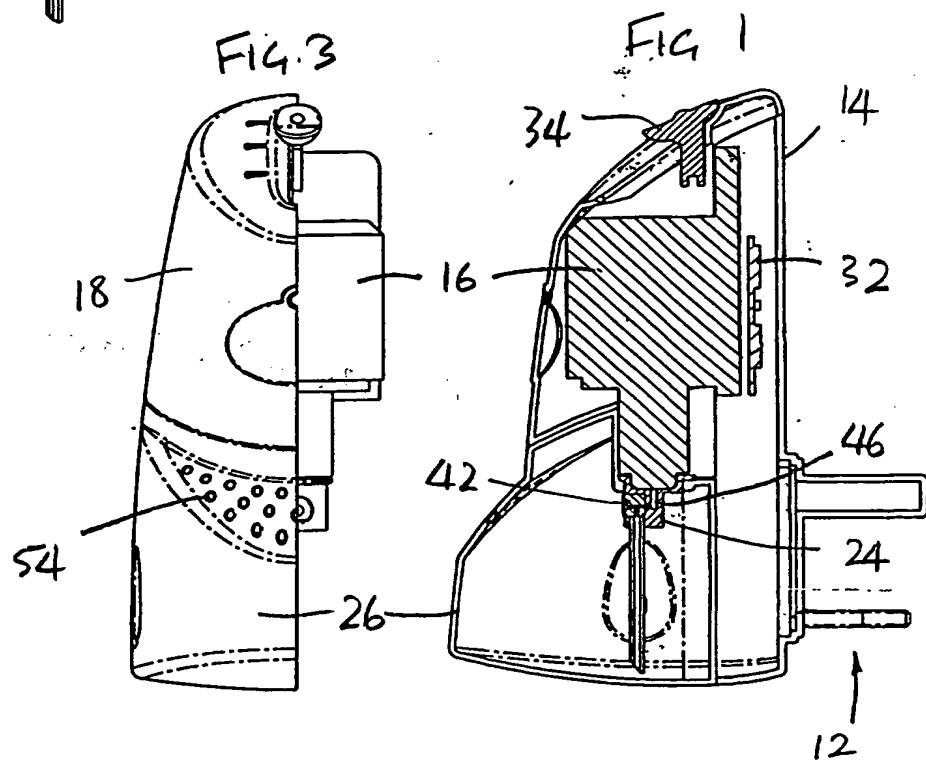
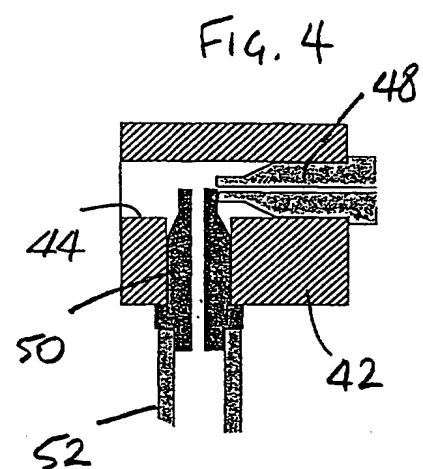
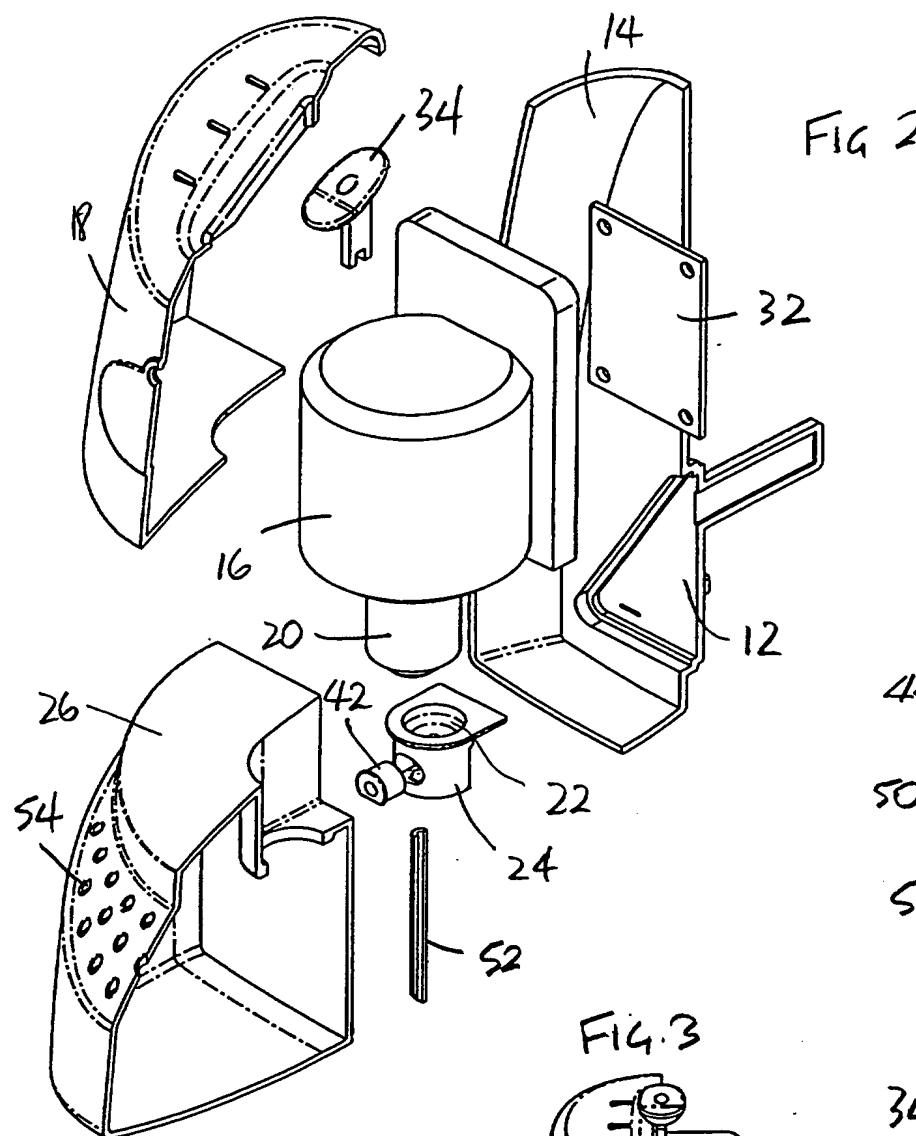
## DISPENSING DEVICES

**ABSTRACT**

A liquid dispensing device for dispensing a liquid into the surrounding atmosphere employs a forced airflow through a small cross-section outlet nozzle (48) to draw the liquid from an adjacent exit nozzle (50) into the airflow. The air outlet nozzle preferably has a cross-section less than that of the liquid exit nozzle. The liquid exit nozzle may partially overlie the airflow path from the air outlet nozzle. The nozzle may be formed in or carried by a unit (24) having sealed connections with the airflow source (16) and a container holding the liquid.

(Fig. 2)

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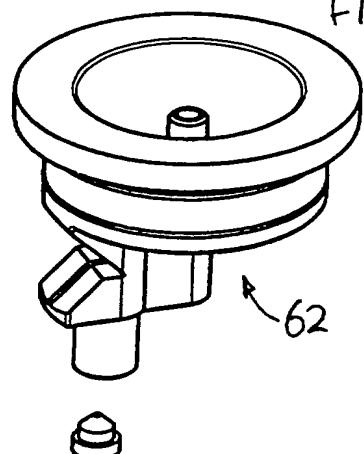


FIG. 7

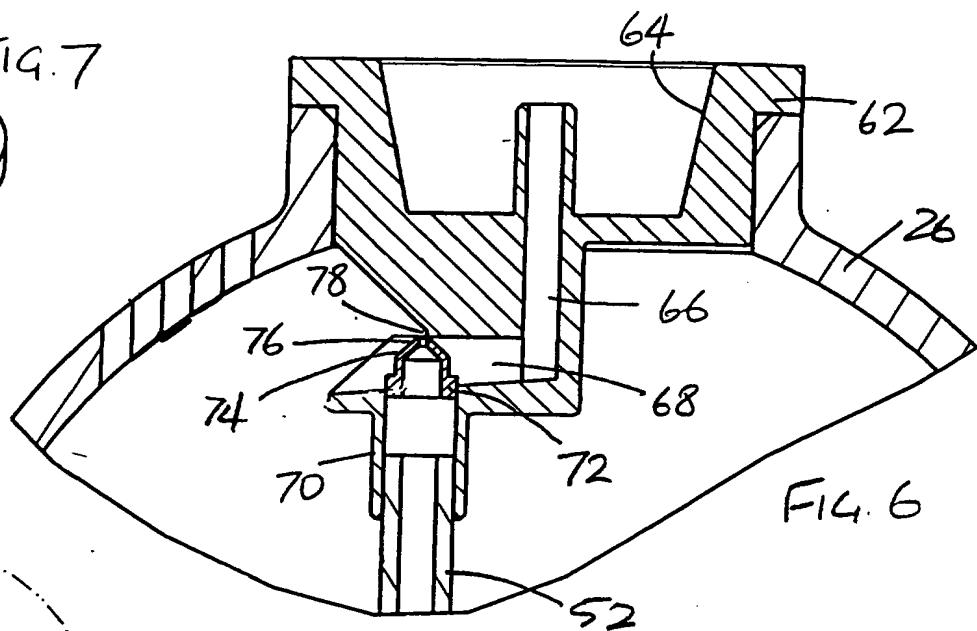


FIG. 6

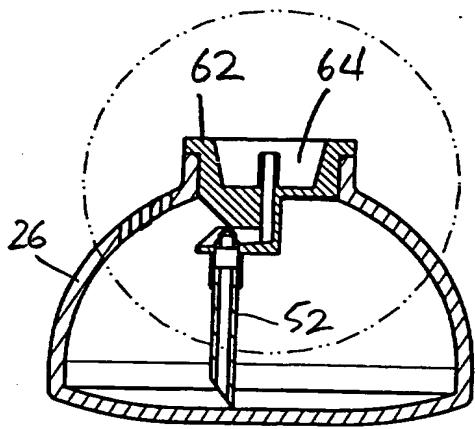


FIG. 5

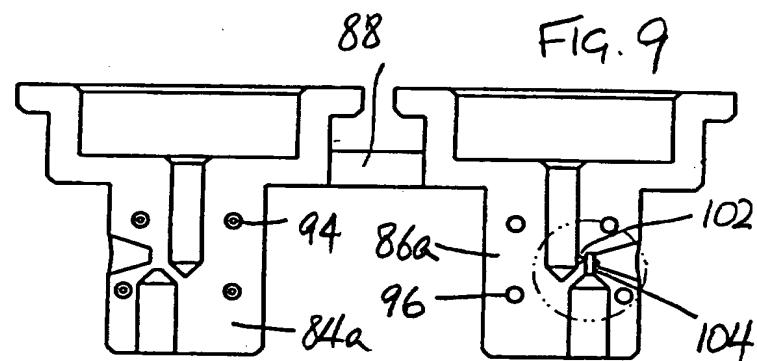


FIG. 9

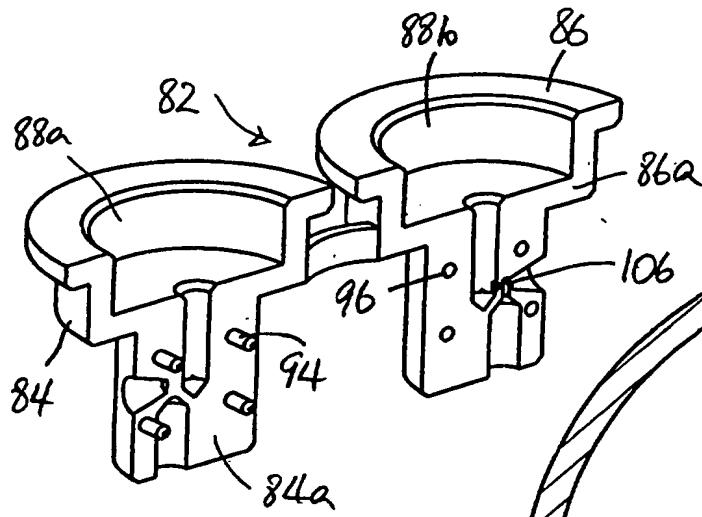


FIG. 10

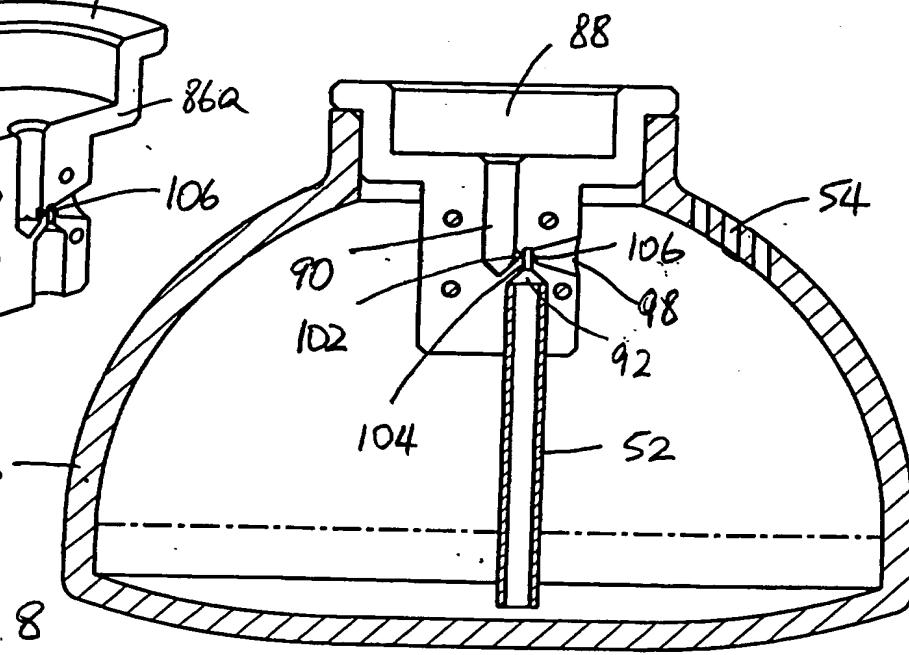


FIG. 8

FIG. 12

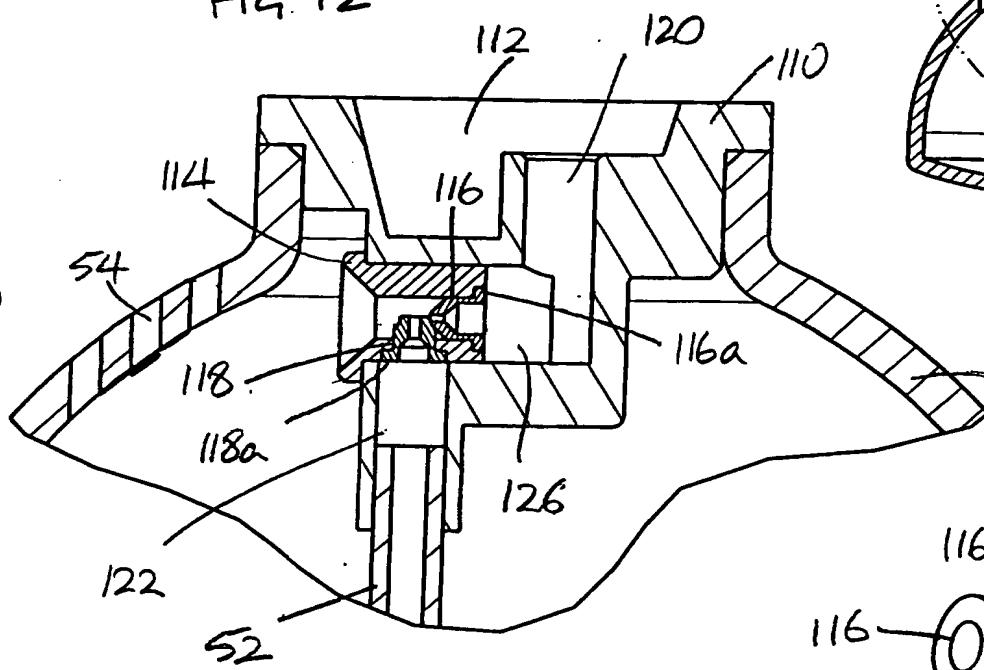


FIG. 11

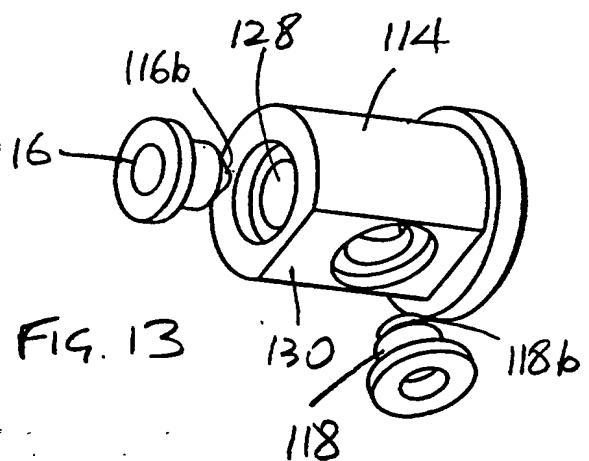
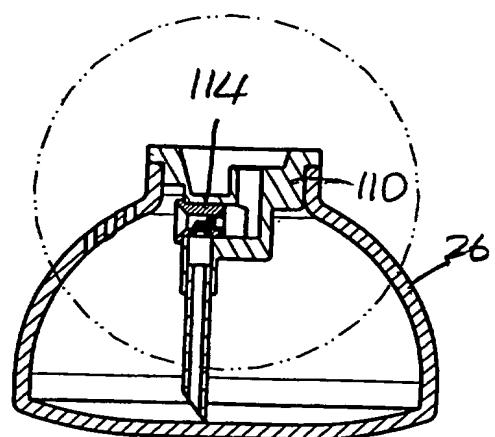


FIG. 13

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